Improved Deep Trench Structure Manufacturing Process

BACKGROUND OF THE INVENTION

1.Field of the Invention

The present invention relates to a semiconductor manufacturing process, more specifically, to a deep trench structure manufacturing process, which is able to reduce leakage problems, thereby lifting the electrictal performance of products.

2. Description of the Prior Art

In semiconductor deep trench manufacturing process, with reference to Fig. 1a, a deep trench is formed in a substrate 10 on which a pad oxide layer and a pad nitride layer 11are formed. Then a thin dielectric layer, preferably a nitride layer of which the material is preferably silicon nitride, is formed to cover the sidewall and bottom of the deep trench. Then, a first polymer 13 is deposited in the deep trench. The portion of the nitride layer not covered with the first polymer 13, which can be poly-silicon, is removed, and the portion of the nitride layer 12 covered with the first polymer 13 is left. As shown in the drawing, when the portion of the nitride layer is removed by etching, the nitride layer 12 is usually etched to a level lower than the top of the first polymer 13, so that a gap 15 is formed.

Subsequently, according to the deep trench process of the prior art, a portion of the sidewall of the deep trench not covered with the first polymer 13 is oxidized by, for example, thermal oxidation to form an oxide layer 14, as shown in Fig. 1b. For the sake of convenient description, the oxide layer 14 refers to a preliminary oxide layer.

An oxide is formed in the deep trench by chemical vapor deposition (CVD) or any other proper method, and etched by dry etching or any other proper method to form a collar oxide layer 16 on the portion of the sidewall of the deep trench not covered with the first polymer 13. Then the deep trench is filled with a second polymer 17 upon the first polymer 13, as shown in Fig. 1c. However, in practical manufacturing process, the collar oxide layer 16 fails to enter the gap 15. Accordingly, the gap 15 still exists even after the collar oxide layer 16 is formed.

Then, portions of the oxide layers 16 and 14 not covered with the second polymer 17 are removed by wet etching other any other proper method. Generally, the oxide layers are etched to a level lower than the top of the second polymer 17, as shown in Fig. 1d.

Finally, the deep trench is filled with a third polymer 18 upon the second polymer 17, so

that the structure as shown in Fig. 1e is finished.

The above process has some problems. As stated above, in the deep trench structure, a gap is likely to be formed between the nitride layer 12 and the collar oxide 16, leading to a path for junction leakage, thereby influencing the sub-threshold leakage and accordingly the electrictal performance of the entire structure. In addition, since the formation of the preliminary oxide 14 is due to the reaction between sidewall of the deep trench and oxygen, and a portion of the preliminary oxide layer is removed in the step of removing oxide as shown in Fig. 1d, the critical dimensions of the opening and the upper portion of the deep trench are increased, so as to influence the aspect ratio of the deep trench.

Therefore, there is a need for a solution to overcome the problems stated above. The present invention satisfies such a need.

SUMMARY OF THE INVENTION

An objective of the present invention is to provide a deep trench structure manufacturing process, which can avoid a gap being generated in the structure as a path of junction leakage, to reduce sub-threshold leakage and maintain good electrictal performance.

Another objective of the present invention is to provide a deep trench structure manufacturing process, which can maintain high aspect ratio for the deep trench.

According to an aspect of the present invention, a deep trench structure manufacturing process comprises the steps of providing a substrate; forming a deep trench in said substrate; forming a dielectric layer in said deep trench, said dielectric layer covering the sidewall and bottom of the deep trench; filling the deep trench with a first polymer; removing a portion of said dielectric layer not covered with the first polymer; refilling the deep trench with another dielectric layer covering the sidewall of the deep trench not covered with the first polymer; removing unnecessary portion of said another dielectric layer; forming a collar oxide layer in the deep trench, said collar oxide layer covering the sidewall of the deep trench not covered with dielectric layers; filling the deep trench with a second polymer; removing a portion of said collar oxide layer not covered with the second polymer; and filling the deep trench with a third polymer.

According to another aspect of the present invention, in the deep trench structure manufacturing process, the material of said another dielectric layer is preferred to be nitride.

According to a further aspect of the present invention, in the deep trench structure manufacturing process, the material of said another dielectric layer is preferred to be silicon nitride.

According to a still further aspect of the present invention, in the deep trench structure manufacturing process, the material of said another dielectric layer is preferred to be the same as that of said dielectric layer.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings are only for illustrating the mutual relationships between the respective portions and are not drawn according to practical dimensions and ratios. In addition, the like reference numbers indicate the similar elements.

Figs. 1a to 1e are sectional schematic diagrams showing the respective steps of the prior art deep trench manufacturing process; and

Figs. 2a to 2f are sectional schematic diagrams showing the respective steps of a deep trench manufacturing process in accordance with the present invention.

DETIALED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described in detail with reference to the accompanying drawings.

The structure shown in Fig. 2a is identical to that of Fig. 1a, and therefore the description thereof is omitted herein. In this drawing, reference number 20 is a substrate, 21 is a pad nitride layer, 22 is a nitride layer (SiN in general), 23 is a first polymer.

Next, with reference to Fig. 2b, a dielectric layer 25 is formed in the deep trench. The material of the dielectric layer 25 is preferably nitride, and more preferably the same as the material of the nitride layer 22. In the present embodiment, the material of the dielectric layer 25 is SiN. In other words, after the deep trench is filled with the first polymer 23 and the unnecessary portion of the nitride layer 22 is removed, the deep trench is refilled with SiN or any other proper material. Due to the characteristic of the material, the refilled SiN enters into a gap 24 between the sidewall of the deep trench and the first polymer 23. The gap 24 is generated due to the level of the nitride layer 22 being lower than the first polymer 23.

Than, an unnecessary portion of the refilled nitride layer 25 is removed. Preferably, only the portion of the nitride layer 25 entering into the gap 24 remains, as shown in Fig. 2c.

The subsequent process steps are similar to those of the prior art. With reference to Figs.

2d to 2f, the subsequent steps include forming a collar oxide layer 26, filling the deep trench with a second polymer 27, removing an unnecessary portion of the collar oxide layer 26, and finally filling the deep trench with a third polymer 28.

As shown in the drawings, there is no gap existing in the deep structure made by the process in accordance with the present invention. Accordingly, the occurrence of leakage can be reduced, and the sub-threshold performance can be kept good. In addition, the process in accordance with the present invention does not need to form the preliminary oxide layer on the sidewall of the deep trench. Thus, in the step of removing the unnecessary portion of the oxide layer, the critical dimension of the diameter of the deep trench will not be increased, and therefore the aspect ratio of the deep trench can be maintained high.

While the embodiment of the present invention is illustrated and described, various modifications and alterations can be made by persons skilled in this art. The embodiment of the present invention is therefore described in an illustrative but not restrictive sense. It is intended that the present invention may not be limited to the particular forms as illustrated, and that all modifications and alterations which maintain the spirit and realm of the present invention are within the scope as defined in the appended claims.